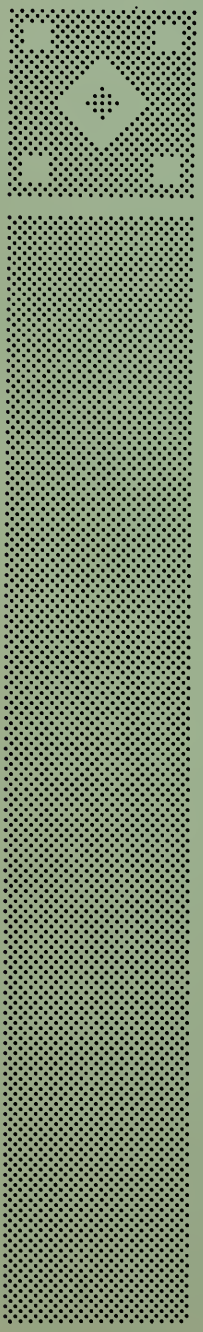
ATERSHED WORK PLAN
r
WATERSHED PROTECTION
and
FLOOD PREVENTION



ROCK CREEK WATERSHED
BUTLER AND COWLEY COUNTIES, KANSAS

MAY 1964

USDA-SCS-LINCOLN, NEBR 1964


United States
Department of
Agriculture
National Agricultural Library

WATERSHED WORK PLAN

ROCK CREEK WATERSHED

Butler and Cowley Counties, Kansas

Prepared Under the Authority of the
Watershed Protection and Flood Prevention Act
(Public Law 566, 83rd Congress; 68 Stat. 666), as amended

Prepared by

Butler County Soil Conservation District
Cowley County Soil Conservation District
Rock Creek Watershed Joint District No. 28

With Assistance by

U. S. Department of Agriculture
Soil Conservation Service

May 1964

TABLE OF CONTENTS

TABLE OF CONTENTS

WATERSHED WORK PLAN

ROCK CREEK WATERSHED
Butler and Cowley Counties, Kansas

May 1964

SUMMARY OF PLAN

This plan for watershed protection and flood prevention is sponsored by the Rock Creek Watershed Joint District No. 28 and the Butler and Cowley County Soil Conservation Districts. Technical assistance in preparing the watershed work plan was provided by the Soil Conservation Service, United States Department of Agriculture. The Soil Conservation Service negotiated contracts with Servis, Van Doren, and Hazard, Engineers, Topeka, Kansas, and Bucher and Willis, Engineers, Salina, Kansas, to collect and process engineering data. The State of Kansas, through the State Soil Conservation Committee, provided funds for these services.

Rock Creek Watershed, with a drainage area of 134 square miles or 85,850 acres, is located in the Bluestem Hills of south central Kansas. It is one of seven organized watershed districts in the Walnut River Basin. The seven watershed districts encompass 1,853 square miles of the 1,955 square miles of the Walnut River drainage area. One watershed project is authorized for installation, three are currently being planned under authority of Public Law 566, two watershed districts have submitted four applications and one is in the process of preparing an application. The locationsof these watersheds and proposed water resource projects of other agencies are shown on the Walnut Basin Map.

Floodwater damage to crops, land, other agricultural property, and roads and bridges are the principal watershed problems. Average annual flood damages in the watershed under existing conditions are estimated to be $148,700. The average annual damage after project installation, including land treatment and structural measures, is estimated to be $52,700. The difference of $96,000 represents an over-all average annual reduction in flood damages of 65 percent.

Works of improvement will include needed land treatment measures together with structural works consisting of 23 floodwater retarding structures. The reservoirs will have a total capacity of 17,082 acre feet of which 14,231 acre feet are for detention storage and 2,851 acre feet are for sediment storage. This system will regulate runoff from a drainage area of 68.59 square miles which is 51 percent of the watershed area.

A period of five years is proposed for installing the needed works of improvement at an estimated total cost of $2,350,000. $2,080,500 will be Public Law 566 funds and $269,500 will be from other sources.

The cost of the land treatment measures for watershed protection is estimated at $155,600. The share from P.L. 566 funds, consisting

entirely of technical assistance is $28,300. The share from other funds is estimated at $127,300. Cost sharing and technical assistance available under other programs will be utilized in applying these measures.

The total cost of all structural measures is $2,194,400 of which $2,052,200 will be borne by P.L. 566 funds and $142,200 by local interests.

Total average annual benefits of the project are $164,500, of which $3,300 are attributed to land treatment measures and $161,200 result from structural measures. Damage reduction by works of improvement will result in benefits of $96,000 within the watershed. Benefits accruing from changed land use are $14,600 and from more intensive use are $10,900. Benefits of $26,500 accrue to the project from the flood plain lying below the watershed boundary. Secondary benefits of $16,500 will be realized from the project. Incidental recreation benefits will be realized from the project but were not tabulated in this plan.

The ratio of the total average annual benefits from structural measures, $161,200, to the average annual costs, $75,800, is 2.1 to 1.0.

Rock Creek Watershed Joint District will provide land easements and rights-of-way and will contract for construction of the structural measures. The Watershed District Act requires the method of financing be adopted concurrently with the adoption of the general plan.

Land treatment measures will be maintained by landowners and operators of the farms on which measures are installed. This will be accomplished by agreement with the Butler and Cowley County Soil Conservation Districts.

Floodwater retarding structures will be operated and maintained by the Rock Creek Watershed Joint District at an estimated average annual cost of $6,300.

DESCRIPTION OF THE WATERSHED

Physical Data

The Rock Creek Watershed lies in the Bluestem Hills area of south central Kansas. The watershed district boundary includes an area of 85,850 acres. About 60,260 acres are in Butler County and 25,590 acres are in Cowley County. The area is about 30 miles long and averages about six miles in width.

Rock Creek begins in Butler County about 9 miles northeast of Latham, Kansas, flows southwest, and discharges into the Walnut River about one mile south of Rock, Kansas.

Butler County State Lake No. 2 is located in the watershed 3 miles northwest of Latham. This state fish and game lake has a surface area of 124 acres with a storage capacity of 1,060 acre feet.

Elevations range from 1,550 feet in the uplands of the watershed to 1,140 feet at the lower end, giving a total fall of 410 feet. Two hundred forty feet of fall occurs in the top 15 miles, with 170 feet distributed in the lower 15 miles.

Rock Creek lies in the Flint Hills Upland Physiographic Province. The upper third is gently rolling with shallow valleys cut in cherty limestone. The lower subwatersheds are more rolling, and the streams are deeply incised in thick limestone beds.

The upland soils are chiefly silty clay loam with some claypan. Shallow and gravelly limestone soils occur in the vicinity of rock outcrops. The flood plain soils are predominately silt loams of the Arvonia and Coffey soil series. These are very dark soils with friable or moderately friable silty to clayey subsoils.

Land use in the watershed includes approximately 73 percent native pastureland, 23 percent cropland, 2 percent woodland, and 2 percent miscellaneous. Native vegetation consists of tall grasses and is generally in excellent condition. Timber is located primarily in the bottomlands along the entire length of Rock Creek and its tributaries.

Average annual precipitation for Winfield, Kansas, 14 miles south of the watershed, is 32.01 inches. Annual precipitation amounts have varied from 19.61 inches in 1956 to 44.20 inches in 1944. Normally, about 70 percent of the precipitation falls during the growing season, April to October. The most intense flood-producing storms occur during the summer months. The highest temperature recorded at Winfield is 118 degrees and the lowest temperature recorded is 27 degrees below zero. The average date of the last killing frost is April 15 and the first killing frost is October 20. The average length of growing season is 188 days.

Economic Data

Land in the watershed is divided among approximately 120 owners. There are 180 farms and ranches in the watershed. The average size of an operating unit is 480 acres.

The rangeland is valued at $80 per acre. Cropland is valued at $100 per upland acre and $200 per flood plain acre.

A majority of the farmers specialize in beef production, utilizing native pasture which covers 73 percent of the watershed area. Winter feeding of cattle and cash crop production are major enterprises in the lower reaches of the watershed where less pastureland is available. Wheat, feed grains, and alfalfa are the principal cultivated crops. Land use in the watershed is as follows:

Land Use	Watershed Total	Flood Plain
Cropland	19,740	4,565
Pasture	62,670	571
Woodland	1,720	571
Miscellaneous	1,720	515
Total	85,850	6,222

The economy of the area depends to a great extent upon feed grain and alfalfa produced on the flood plain. Farmers, therefore, try to keep these lands in crop production despite frequent and damaging floods. The 4,565 acres of flood plain cropland represent about 23 percent of the cropland in the watershed. Small grains, alfalfa, sorghums, corn, and soybeans in the order named are the principal crops grown on the flood plain. About 9 percent of the flood plain area is devoted to tame grass production.

The system of roads shown on the project map provides access to all parts of the watershed. The road system is considered adequate except when interrupted by high water or flood damage.

Latham, with a population of 203, and Rock, with a population of approximately 150, are the only towns lying within the watershed boundary. Some of the population centers within 30 miles of the watershed are: Wichita - 254,698; Augusta - 6,434; El Dorado - 12,523; Howard - 1,017; Winfield - 11,117; Arkansas City - 14,262; and Wellington - 8,809. These and other nearby towns provide adequate market facilities.

The Atchison, Topeka and Santa Fe Railroad serves the town of Rock at the lower end of the watershed, and the St. Louis San Francisco Railroad serves the town of Latham at the upper end of the watershed.

Oil and gas production plays an important role in the area's economy. Pipelines necessary for the collection and distribution of these products are much in evidence. Pumping and storage facilities are located in the flood plain.

WATERSHED PROBLEMS

Floodwater Damage

Damage resulting from the flooding of flood plain lands and facilities is the principal problem. Rock Creek is noted for its devastating and frequent floods. In 1959 two destructive floods occurred, one of them causing major damage. Two large floods occurred in 1961, one in July and one in September. The September 1961 flood inundated more than 80 percent of the flood plain.

The flood plain covers 6,222 acres and includes 4,565 acres of cropland valued at $200 per acre. Crop damage due to flooding averages $84,500 annually and accounts for 57 percent of the total flood damage. Flooding is usually of short duration with high velocity flows the major cause of flood damage.

Flooding causes damage to buildings, fences and machinery. Damage to fences is extremely high, many miles being destroyed or damaged even by minor floods. Most buildings have been moved out of the flood plain because of the frequency of flooding; however, such installations as cattle and hog pens, feed bunks, and stock tanks are frequently damaged. Considerable expense is incurred for clean up of debris after flooding. Agricultural damage of this type averages about $19,400 annually.

Floodwater damage to roads and bridges is extensive, amounting to $12,700 on an average annual basis. Flood flows wash away road surfacing, scour road shoulders, silt in roadside ditches, and damage bridges. County and township road budgets are not usually sufficient to make immediate replacements and repairs following a flood. Such costs and needed work are spread over a number of years allowing these essential facilities to remain in a subnormal condition.

Small frequent floods, localized in character, cause considerable damage and inconvenience to farmers in the area of their occurrence. Major floods such as those experienced in 1959 and 1961 affect everyone in the area due to damage to roads, bridges, transportation, utilities, and loss of business to those serving the agricultural community. Such indirect losses under present conditions are estimated to average $12,400 annually.

Flood damages to oil field installations are relatively minor and have not been evaluated for this plan.

Sediment Damage

Damage from sediment deposition on flood plain land is not a serious problem. Sediments are mainly silts and clays and have only slight detrimental effects on flood plain lands. Some localized gravel deposits cause minor damage. Channel agradation is not a problem.

Sediment deposition in road ditches and ponds is a problem below untreated upland cropland fields.

Erosion Damage

Land damage caused by erosion on the flood plain from flood flows is severe. Large areas of the flood plain are damaged by sheet scour. Very severe damage is caused on smaller areas by the cutting of deep scour channels. Flooding has caused scour damage on about 22 percent of the

flood plain. This has reduced the productive capacity of the damaged areas by 28 percent. Average annual erosion damage to the flood plain under present conditions amounts to $19,100.

Upland erosion on sloping cropland constitutes a serious problem. Conservation measures have been effective in controlling this erosion. Land damage is causing depletion of cropland on those areas not having land treatment.

Problems Relating to Water Management

There is insufficient interest or need to include irrigation or drainage as a project purpose. The soils of the flood plain are not well adapted to irrigation. There is no interest in development of water storage for other agricultural or non-agricultural uses.

PROJECTS OF OTHER AGENCIES

Butler County State Lake No. 2 is located in the northeast part of the watershed at the lower end of reach 6B (See project map). This 124 acre lake is maintained normally at spillway level with only a minor detention effect on flood flows. Water level of this reservoir is controlled by releasing water through a 10-inch corrugated metal pipe. Floodwater retarding structure No. 16 will greatly reduce sediment inflow to this lake.

The Corps of Engineers, Tulsa District, under authority of the House of Representatives Public Works Committee Resolution, adopted 16 October, 1951, has recently developed a "Survey Report on Walnut River, Kansas." The plan of improvement includes El Dorado, Douglass and Towanda Reservoirs, modification of the Winfield levee, and a local protection project on the west branch of the Walnut River at El Dorado. This plan has been coordinated with the Corps of Engineers to insure that the works of improvement are harmonious elements for the development of the water resources of the Walnut River Basin.

BASIS FOR PROJECT FORMULATION

The desire of the local sponsoring organization is to reduce to the greatest degree economically possible, floodwater damage to the land, crops and other valuable properties within the flood plain. This must be accomplished with the least possible encroachment on flood plain land which constitutes the heart of a balanced agriculture in the watershed. Without the crops that are produced on the flood plain, a major cattle feeding enterprise would not be economically practical.

Topography of the watershed provides numerous sites for dam construction. Roads, pipelines, utilities, railroads, farm buildings, etc. were physical and economic factors influencing the selection

of structure sites. The system of physically feasible and economically justified tributary structures was formulated to provide the highest degree of flood protection economically sound while still permitting optimum use of flood plain lands.

The inclusion of mainstem structures to provide increased benefits in the lower reaches would not offset the loss of benefits in the upper reaches and in the reservoir areas of such structures.

Channel improvement as a method of increasing flood protection would be impractical for this watershed. Enlargement of existing channels, in many cases, would involve excavation into limestone.

WORKS OF IMPROVEMENT TO BE INSTALLED

Works of improvement to be installed consist of the necessary land treatment measures for watershed protection plus 23 floodwater retarding structures (See table 1).

Land Treatment Measures

The application of land treatment measures is essential to a sound and continuing watershed protection and flood prevention program. This is accomplished by the establishment and maintenance of all soil, water, and plant management practices essential for each land use. The result will be a reduction in runoff rates, erosion damages and sediment yield.

Standard soil surveys will be completed over all the watershed. Farmers and ranchers cooperating with the soil conservation district will develop conservation plans that will achieve proper land use and meet the basic conservation needs of the land. Rangeland will continue to be the major land use with some improvement being made in its condition. Cropland conversion will continue with the major change being to range and pasture with small amounts going to recreation, water and miscellaneous uses. The trend in cropland use to more close grown crops is expected to continue.

Treatment on the cropland will include conservation cropping systems, grassed waterways, terraces, contour farming and crop residue use, plus feasible fertilizer programs. Technical assistance will be required primarily on the first three practices. This treatment will be essential on the relatively large acreage of cropland on the upland above the floodwater retarding structure sites.

Treatment on the rangeland will include range proper use, construction of stockwater ponds, range deferred grazing, and management practices to achieve proper grazing distribution. A high percent of the rangeland is being properly used. Greatest overuse occurs during drouth years.

Most of the areas of woodland do not lend themselves to efficient management and some of the sites do not have the potential for economical wood production. They will have some value for wildlife habitat and for recreational areas.

The amounts and costs estimates of the land treatment to be applied during project period are shown in table 1. The estimated total cost of soil surveys, planning and installing the land treatment measures is $155,600. Public Law 566 funds will be furnished in the amount of $28,300 to provide technical assistance to accelerate the current program. Funds from other sources will be provided in the amount of $127,300 for installing these measures.

Structural Measures

A system of 23 floodwater retarding structures will be installed at the locations shown on the project map. Features of typical floodwater retarding structures with principal spillways having two stage inlets are shown on the drawing following page 38. Physical data for structures is presented in table 3.

The system will provide 14,231 acre feet of floodwater detention storage, 2,851 acre feet of sediment storage for a total of 17,082 acre feet. The system will control the runoff from a drainage area of 68.59 square miles. This is 51 percent of the watershed area.

Floodwater retarding structures have been planned with floodwater storage ranging from 3.46 to 4.55 inches of runoff from their drainage areas. Storage will be provided for the expected 100-year accumulation of sediment with a storage volume equivalent ranging from 0.48 to 1.15 inches per acre from the drainage area above detention structures. Water will be stored in the sediment pools, not to exceed the 50-year sediment accumulation level.

Floodwater retarding structures will be earth dams with two-stage outlets in the principal spillways. The principal spillways will be reinforced concrete or a comparable quality material. They will have an uncontrolled release rate of 10 c.s.m. through the lower stage with an additional 15 c.s.m. through the upper stage. Emergency spillways will be provided to release runoff exceeding reservoir storage capacity safely past the embankment. These spillways have been planned so that their chance of operation is 4 percent or less.

The floodwater retarding structures will be installed at an estimated total cost of $2,194,400. The estimated cost of individual structures is shown in table 2.

EXPLANATION OF INSTALLATION COSTS

Areas needing treatment and estimated costs of land treatment measures are shown in table 1. The estimated total cost of planning and installing land treatment measures is $155,600. Public Law 566 funds will be furnished in the amount of $28,300 to provide technical assistance to accelerate the current program. Funds from other sources will be provided in the amount of $127,300 for installing these measures.

Public Law 566 costs for structural measures for flood prevention include construction cost and installation services cost. Construction cost includes general construction and vegetative establishment work of the character normally performed by contractors. Installation services include engineering, administrative service and overhead costs of programming and supervision.

Engineering services include all direct and related costs of the services of engineers and geologists for surveys, geologic site investigations and soil mechanics, structure design, construction plans and specifications, construction engineering and supervision. Administrative services include assistance rendered to the local contracting organization in preparing invitations to bid and in awarding construction contracts. Overhead costs include administration and program supervision at all levels concerned with the installation of the program.

Engineering service costs were computed as a percent of construction cost where functions are proportional to construction cost. Flat rates were used in computing functions with relatively fixed costs. Administrative services costs were computed at 8 percent of construction cost.

Construction cost estimates in this plan are based on computation of quantities derived from survey data at each site using unit costs for similar work on watershed projects currently under construction with a contingency allowance of 12 percent. At the time of project installation, additional surveys will be needed at the dam sites as a basis for structural design and construction cost estimates. Geologic drilling and soil mechanic tests and analysis will be performed to verify site and foundation conditions. Reservoir storage volumes will be computed from topographic maps made during work plan preparation.

Land, easements, and rights-of-way values were determined by the Board of Directors of the Rock Creek Watershed Joint District. Cost estimates were based on current land values varying from $80 per acre for rangeland to $100 per acre for upland cropland. It is recognized that such values may not coincide with actual out-of-pocket costs to the local sponsoring organization because some easements and rights-of-way may be obtained by donation.

Contract administration costs of the local contracting organization will include cost of mailing bid invitations, salary, if any, and expenses

of the contracting officer in administering construction contracts. Contract administration costs were estimated on the basis of experience of other watershed districts in Kansas which have carried out construction work.

The estimated total P.L. 566 structural cost and other obligations by fiscal years during the project installation period are as follows:

Fiscal Year	P.L. 566 Costs	Other Costs	Total
First	275,400	40,000	315,400
Second	432,600	63,900	496,500
Third	311,000	41,100	352,100
Fourth	510,900	66,500	577,400
Fifth	550,600	58,000	608,600
Total	2,080,500	269,500	2,350,000

The cost of applying land treatment measures is based on current costs of applying such measures under going programs.

EFFECTS OF WORKS OF IMPROVEMENT

The flood prevention program will directly benefit 120 landowners within the watershed. The program of land treatment and structural measures will reduce flood damages ranging from 100 percent immediately below floodwater retarding structures to 54.2 percent at the outlet of the watershed. The program will accomplish a 64.6 percent reduction in total watershed average annual flood damages. Fifty-five percent of the flood plain will be flood free when the 4-year frequency storm occurs with another 15 percent on which flooding will be less than 1 foot in depth. The area benefited in each reach is shown in the following table:

Reach	Area Benefited Acres	Reach	Area Benefited Acres
1	352	6AX	364
2	592	6AY	242
3	600	6AZ	156
4	755	7X	405
4A	184	7Y	376
5	830	7Z	378
6	395	8	144
		TOTAL 14	5,773

The map on the following page shows the program effect on a modified September 1961 storm. The same areal distribution was used, but the storm volume was reduced by one-half to bring it more in line with frequently occurring storms. This aerial view of the flood plain shows part of reaches 2 and 3 from near the Kelly farm upstream to near the Gilmer farm. The super-imposed lines and cross hatching show flooded area with and without the watershed program. The flooded area shown was reduced from 290 acres to 70 acres or a reduction of 76 percent. For this same storm works of improvement reduced the total watershed flood plain area flooded from 1,616 acres to 440 acres or by 73 percent.

Reduction in the depth and frequency of flooding will substantially reduce crop losses. The reduction in the flood hazard will induce farmers to use more fertilizer, improved crop varieties, and establish soil building rotations. Farmers will be able to perform tillage, planting, and harvesting operations on a timely basis for improved production.

Losses in productivity due to removal of soil by flood plain scour will be substantially reduced. The reduction in flooding will likewise make it possible to restore productivity on previously damaged land at a more rapid rate.

A substantial reduction in costs of maintaining roads and bridges on the flood plain will be realized. The reduction in cost of repairing flood damages will release road and bridge funds for use in improving and modernizing the existing road system.

The watershed project will bring about a land use adjustment. A more complete job of conservation farming on the upland will cause a conversion of some cropland to pasture. A reduction in frequency of flooding on the flood plain will allow 551 acres of land now in brushy pasture and timber to be converted to cropland. The construction of the 23 floodwater retarding structures will convert both pasture and cropland to water storage in the sediment pools. Land used for crop and tame pasture with and without the watershed project is shown in the following table:

Acreage and Use of Cropland

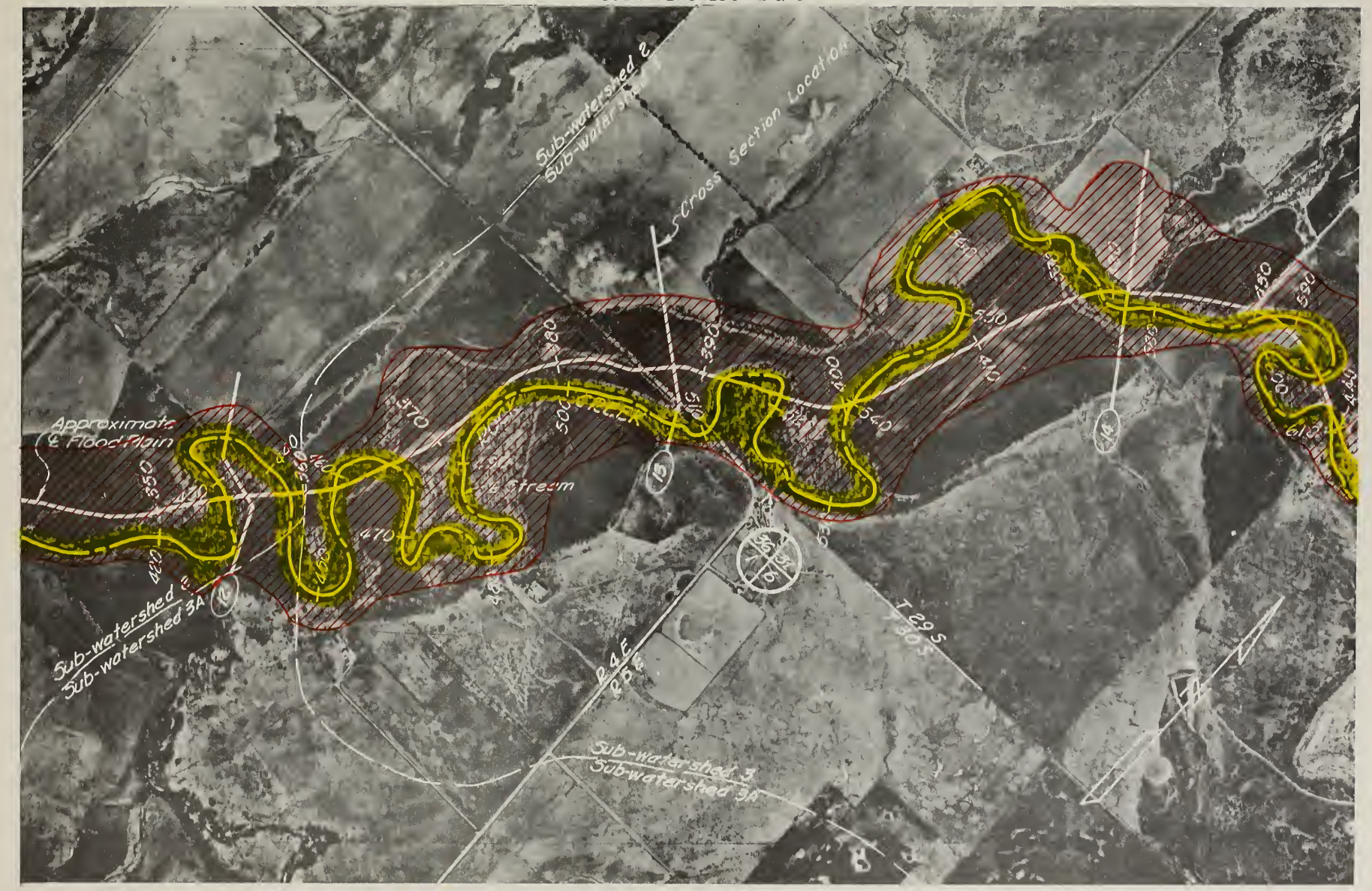
Crop and Tame Pasture	Without Project (Acres)	With Project (Acres)
	Flood plain Area	
Alfalfa	1,141	1,330
Wheat	1,552	1,535
Grain Sorghum	958	921
Corn	274	256
Forage Sorghum	183	256
Tame Grass	571	433
Barley	183	153
Soybeans	137	563
Oats	137	102
Subtotal	5,136	5,549
	Remaining Area	
Alfalfa	1,973	1,874
Wheat	5,615	5,335
Grain Sorghum	3,794	3,605
Corn	607	577
Forage Sorghum	1,062	1,009
Tame Grass	4,000	4,148
Barley	607	577
Soybeans	910	865
Oats	607	577
Subtotal	19,175	18,567
	Total Watershed	
Alfalfa	3,114	3,204
Wheat	7,167	6,870
Grain Sorghum	4,752	4,526
Corn	881	833
Forage Sorghum	1,245	1,265
Tame Grass	4,571	4,581
Barley	790	730
Soybeans	1,047	1,428
Oats	744	679
Total	24,311	24,116

U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

ROCK CREEK WATERSHED - COWLEY & BUTLER COUNTIES KANSAS

AREA FLOODED WITH AND WITHOUT PROJECT
BY MODIFIED SEPTEMBER 1961 STORM
IN SUBWATERSHEDS 2 & 3



AREA FLOODED WITHOUT PROJECT

AREA FLOODED WITH PROJECT INSTALLED

SCALE IN FEET
600 0 600 1200

USDA SCS-LINCOLN NEBR 1964

5,0-19,917

Facilities necessary for the collection, storage and distribution of oil and gas will benefit from the installed flood prevention measures. The costs necessary to relocate or protect pipelines affected by floodwater retarding structures have been determined by coordination with the appropriate petroleum and pipeline companies. All elements of this project are harmonious with known mineral resources.

Works of improvement will provide important benefits to an area of 19,800 acres below the watershed boundary. These have been jointly evaluated by the Kansas Board of Water Resources; Corps of Engineers, Tulsa District; and the Soil Conservation Service. Benefits from the reduction of flooding to 19,390 acres of agricultural land, 410 acres of urban area, transportation facilities, and public utilities will accrue along the mainstem of the Walnut River from the mouth of Rock Creek to its junction with the Arkansas River.

Secondary benefits stemming from the project are realized from transporting, processing and marketing agricultural commodities produced as a result of reducing crop losses by flooding. Secondary benefits induced by the project include the increased net return to suppliers of farm equipment and materials required to achieve the increased agricultural production made possible by the project, the increased net return to local retailers and wholesalers from consumer expenditures by the farm family resulting from increased farm income, and any other increase in net returns resulting from costs directly associated with marketing or using project goods or services. Secondary benefits from a national viewpoint were not considered pertinent to the economic evaluation.

Recreational benefits in Rock Creek Watershed will accrue to the public. There are 23 flood retarding reservoirs with sediment pools ranging in size from 6 to 44 acres. The pools will provide opportunities for developing facilities for fishing, boating, and hunting. In addition, suitable sites for camping will be available in the area surrounding this water.

A general benefit to the fish and wildlife resources of the area is expected. Stream fishing will be improved as a result of more stabilized flows below the floodwater retarding structures. Permanent storage pools in the floodwater retarding reservoirs will increase the fishing opportunities in the watershed. Increased water area of some 372 acres widely distributed over the watershed will benefit waterfowl by providing resting areas and some winter habitat. Upland game birds will be displaced from the permanent pool area of the detention structures, but terrestrial species will benefit from flood reduction in the protected bottomlands where not intensively cultivated. Landowners and operators will be encouraged to include wildlife conserving practices along with other conservation measures on their lands.

PROJECT BENEFITS

Benefits of $164,500 accrue to flood prevention. Of these $3,300 accrue to land treatment measures and $161,200 are attributable to floodwater retarding structures. Individual items of benefit are shown in tables 5 and 6.

Benefits from reduction in floodwater damage to crops average $55,100 annually and account for 40 percent of the flood prevention benefits within the watershed. The reduction of the flood hazard makes possible benefits from more intensive use of land through improved crop rotations and use of fertilizer averages $10,900 annually and benefits from changed land use $14,600 annually within the watershed.

Benefits from reducing damages to flood plain land by scour will average $9,500 annually, accounting for 7 percent of the total flood prevention benefits within the watershed. Benefits from reduction in floodwater damage to roads, bridges, and railroads amount to $10,300 and similar benefits to other agricultural property such as stored feed, fences, buildings, and other farm improvements are $12,800 on an average annual basis.

Indirect average annual benefits realized from reduction in interruption of travel, halting or delays in mail, school busses, and milk routes amount to $8,300 within the watershed.

The value of local secondary benefits stemming from the project is $13,000 with the value of secondary benefits induced by the project worth $3,500 giving a total value of $16,500 annually.

Flood prevention benefits outside the watershed will accrue from works of improvement including the three proposed Corps reservoirs, one authorized watershed project and six proposed watershed projects. The portion of these benefits assigned to Rock Creek works of improvement averages $26,500 annually. These benefits stem in a large measure from reduction in floodwater damage to crops on the flood plain and to the city of Winfield.

In addition to the monetary benefits, there are other substantial intangible values which will accrue from the project, such as better living conditions, a sense of economic security and abatement of the fear of flood damage.

COMPARISON OF BENEFITS AND COSTS

The average annual cost of structural measures, including installation, operation and maintenance is $75,800. When the project is completely installed, the structural measures are expected to produce average annual benefits of $161,200. Therefore, the project will produce benefits of

$2.10 for each dollar of equivalent cost. (See table 6) The benefit cost ratio based on primary benefits is 1.9 to 1.

PROJECT INSTALLATION

The works of improvement will be installed in a five year period. Federal assistance for carrying out the works of improvement on non-Federal land as described in this work plan will be provided under authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress, 68 Stat. 666) as amended.

Land Treatment Measures

Land treatment measures will be established on the land by the farm owners and operators in cooperation with the Butler and Cowley Soil Conservation Districts. The cost of applying these measures will be borne by the owners and operators of the land. The Soil Conservation Service will provide technical assistance in planning and establishing land treatment measures. Technical assistance to the soil conservation districts will be accelerated to assure application of the planned measures within the five year installation period of the project.

The Extension Service will assist in carrying out the educational phase of the program by preparation of general information in cooperation with the governing bodies of the Soil Conservation and Watershed District Boards. The Farmer's Home Administration soil and water loan program will be available to eligible farmers in the area. The County Agricultural Stabilization and Conservation Committees will cooperate with the governing bodies of the soil conservation districts to accelerate Agricultural Conservation Program financial assistance for those practices which will accomplish the conservation objectives. The supervisors of the Butler and Cowley County Soil Conservation Districts will encourage landowners and operators within the Rock Creek Watershed to install soil and water conservation measures on their farms.

Structural Measures

The Rock Creek Watershed Joint District will contract for the construction of the 23 floodwater retarding structures. All structural measures will be installed through construction contracts awarded on the basis of competitive bidding. Separate contracts will be awarded for general construction and for vegetative establishment. The local sponsoring organization will appoint a contracting officer and will bear the cost of contract administration.

The watershed district will obtain all land rights, easements, and rights-of-way needed for installation of the 23 floodwater retarding structures. The watershed district has power of eminent domain to obtain land rights for public improvements and has agreed to use such

authority when needed. The watershed district will make arrangements with the county commissioners for abandonment, relocation, or modification of any county roads requiring such action. The watershed district will likewise arrange for any relocation or modification of pipelines, communication lines, or other public utilities which are necessary in connection with the project installation.

After Federal assistance is authorized for installation of the project, the Soil Conservation Service will furnish engineering services to prepare construction plans and specifications for structural measures for flood prevention. Construction can then be started when all necessary land easements and rights-of-way have been obtained, P.L. 566 funds are available, and local sponsoring organizations have complied with State laws relating to approval of construction plans.

FINANCING PROJECT INSTALLATION

The Rock Creek Watershed Joint District was created and validated in accordance with the Kansas Watershed District Act as amended. The watershed district has all the necessary authority and power to finance and to carry out watershed improvements. These powers include the right to accept contributions, levy taxes, make assessments against land specially benefited, issue bonds, and exercise the right of eminent domain.

The expenses of organizing the district have been paid and current general expenses are being met by an annual ad valorem tax levy.

The watershed district has been furnished land rights work maps for all structural measures as a basis for contacting landowners and appraising costs to the district. The Board of Directors believe, based on contacts with landowners, that most of the needed land easements and rights-of-way will be donated. Land rights which must be purchased, will be financed by a general tax levy.

Funds for construction costs will be provided to the local sponsoring organizations as grants-in-aid through project agreements for construction executed with the Soil Conservation Service. A project agreement will be executed for each structural measure or group of structural measures to be included in a construction contract.

Federal technical assistance, installation services, and grants-in-aid for construction are contingent upon appropriation of funds for these purposes.

Soil Conservation Districts will seek such allocation of Agricultural Conservation Program funds as are needed to cost share on land treatment measures to meet project objectives within the watershed. Technical assistance available from the Soil Conservation Service in its program of assistance to soil conservation districts will continue at current rates.

PROVISIONS FOR OPERATION AND MAINTENANCE

Land Treatment Measures

The land treatment measures will be maintained by the landowners and operators of the farms on which the measures are installed under agreements with the soil conservation districts serving the area. Representatives of the soil conservation districts will make periodic inspections of the land treatment measures to determine maintenance needs and will encourage landowners to perform needed maintenance.

Structural Measures

An agreement providing for operation and maintenance of the structural measures will be executed by the local sponsoring organizations before Federal construction funds are made available.

The 23 floodwater retarding structures will be operated and maintained by the Rock Creek Watershed Joint District. All structural measures will be inspected by representatives of the Watershed District and the Soil Conservation Service at least annually and after each heavy runoff producing storm. Items of inspection will include but not be limited to the condition of the principal spillway and its appurtenances, the emergency spillway, the earth fill, the vegetative cover of the earth fill and emergency spillway, and any fences installed as a part of the structural measures. The Rock Creek Watershed Joint District will maintain a record of maintenance inspections.

Maintenance work will be carried out when needed. Kinds of maintenance work that would be expected rather frequently are repairs to fence, clearing of debris, mowing of dam and spillway, etc. Repairs to major construction items such as the dam and spillway are expected very infrequently.

The estimated average annual operation and maintenance cost is $6,300. The necessary maintenance will be accomplished through contributed labor and equipment and/or hired labor and equipment. Funds for accomplishing the maintenance work will be obtained from an annual tax levy within the district.

Provisions will be made for free access of District, State, and Federal representatives to inspect the structural system at any time.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

Rock Creek Watershed, Kansas

Installation Cost Item	Unit	Number Non-Fed. Land	Estimated Cost (Dollars) 1/ P.L. 566	Other	Total
Land Treatment					
Soil Conservation Service					
Cropland	Ac.	7,500		94,500	94,500
Rangeland	Ac.	7,000		21,700	21,700
Technical Assistance			28,300	11,100 2/	39,400
TOTAL LAND TREATMENT			28,300	127,300	155,600
STRUCTURAL MEASURES					
Construction					
Floodwater Retarding Struc.	No.	23	1,579,700		1,579,700
Subtotal Construction			1,579,700		1,579,700
Installation Services					
Engineering			346,100		346,100
Other			126,400		126,400
Subtotal Installation			472,500		472,500
Other Costs					
Land, Easements & R/W				135,300	135,300
Administration of Contracts				6,900	6,900
Subtotal Other				142,200	142,200
TOTAL STRUCTURAL MEASURES			2,052,200	142,200	2,194,400
TOTAL PROJECT			2,080,500	269,500	2,350,000

1/ Price base 1963
2/ Includes $4,000 from local watershed district funds

May 1964

TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT

Rock Creek Watershed, Kansas

Measures	Unit	Applied to Date	Total Cost (Dollars) 1/
LAND TREATMENT			
Conservation Cropping System	Acre	14,000	350,000
Proper Range Use	Acre	59,000	5,900
Range Seeding	Acre	240	5,000
Pasture Planting (tame)	Acre	4,000	80,000
Grass Waterways	Acre	82	12,300
Diversions	Mile	5	3,000
Grade Stabilization Structures	No.	2	1,500
Farm Ponds	No.	318	292,000
Terraces - Gradient	Mile	151	55,800
Total			805,500

1/ Price base 1963

May 1964

TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION
Rock Creek Watershed, Kansas

(Dollars)[1/]

Structure Site No.	Installation Cost - P.L. 566 Funds				Installation Cost - Other Funds			Total Installation Cost
	Construction	Installation Services		Total P.L. 566	Adm. of Contracts	Easements & R/W	Total Other	
		Engineering	Other					
1	38,800	11,900	3,100	53,800	300	3,100	3,400	57,200
2	95,300	18,400	7,600	121,300	300	8,400	8,700	130,000
3	58,500	15,400	4,700	78,600	300	6,400[2/]	6,700	85,300
4	150,000	21,200	12,000	183,200	300	11,900	12,200	195,400
5	48,400	13,900	3,800	66,100	300	3,800[3/]	4,100	70,200
6	96,000	18,400	7,700	122,100	300	13,200[4/]	13,500	135,600
7	43,000	12,800	3,400	59,200	300	2,600	2,900	62,100
8	41,800	12,500	3,300	57,600	300	2,900	3,200	60,800
9	41,500	12,500	3,300	57,300	300	2,400	2,700	60,000
10	47,600	13,700	3,800	65,100	300	2,500[5/]	2,800	67,900
11	36,700	11,400	2,900	51,000	300	1,800	2,100	53,100
12	34,100	10,900	2,700	47,700	300	2,600	2,900	50,600
13	38,100	11,800	3,100	53,000	300	2,500[6/]	2,800	55,800
14	43,300	12,800	3,500	59,600	300	2,500	2,800	62,400
15	42,400	12,700	3,400	58,500	300	3,600[7/]	3,900	62,400
16	96,200	18,500	7,700	122,400	300	14,700[8/]	15,000	137,400
17	164,000	22,000	13,100	199,100	300	7,400	7,700	206,800
18	117,700	19,600	9,400	146,700	300	5,900	6,200	152,900
19	56,800	15,300	4,600	76,700	300	3,300	3,600	80,300
20	49,900	14,200	4,000	68,100	300	3,500[9/]	3,800	71,900
21	45,900	13,400	3,700	63,000	300	2,200	2,500	65,500
22	158,100	21,600	12,700	192,400	300	26,000	26,300	218,700
23	35,600	11,200	2,900	49,700	300	2,100	2,400	52,100
Total	1,579,700	346,100	126,400	2,052,200	6,900	135,300	142,200	2,194,400

* See footnotes on following page

FOOTNOTES - Table 2

1/ Price base 1963

2/ Raise road approximately 900' long $1,400

3/ Pipeline $836

4/ Raise road $1,600 and relocate power line $1,000

5/ Relocate power line $300

6/ Relocate seven power poles and re-route line $400

7/ Raise approximately 600' of road $1,200

8/ Buy two sheds $2,000 and relocate power line $1,000

9/ Relocate well and windmill $400

TABLE 3 - STRUCTURE DATA

FLOODWATER RETARDING STRUCTURES

Rock Creek Watershed, Kansas

ITEM	UNIT	STRUCTURE NUMBER 1	2	3	4
Drainage Area	Sq. Mi.	1.67	4.62	2.32	6.36
Storage Capacity					
Sediment	Ac. Ft.	63	210	142	349
Floodwater	Ac. Ft.	308	1,121	467	1,279
Total	Ac. Ft.	371	1,331	609	1,628
Between High and Low Stages	Ac. Ft.	183	599	306	832
Surface Area					
Sediment Pool	Acres	12	24	17	29
Floodwater Pool	Acres	54	142	87	142
Volume of Fill	Cu. Yds.	58,389	161,368	90,118	227,912
Elevation Top of Dam	Feet	1,518.6	1,280.0	1,263.0	1,253.0
Maximum Height of Dam	Feet	25.0	41.0	32.7	47.0
Emergency Spillway					
Crest Elevation	Feet	1,513.6	1,273.3	1,258.0	1,247.9
Bottom Width	Feet	40	80	40	40
Type	--	Rock	Rock	Veg.	Veg.
Percent Chance of Use	--	4	2	4	4
Average Curve No. Cond. II	--	77	80	80	80
Emergency Spillway Hydrograph					
Time of Concentration	Hrs.	1.25	2.25	1.25	2.5
Storm Rainfall (6 hr.)	Inches	6.02	8.63	6.01	6.01
Storm Runoff	Inches	3.49	6.21	3.79	3.79
Velocity of Flow (Vc) 1/	Ft./Sec.	3/	5.4	3/	3/
Discharge Rate 1/	c.f.s.	3/	392	3/	3/
Maximum W. S. Elevation 1/	feet	3/	1,275.3	3/	3/
Freeboard Hydrograph					
Storm Rainfall (6 hr.)	Inches	8.68	14.64	8.62	8.62
Storm Runoff	Inches	5.90	12.02	6.21	6.21
Velocity of Flow (Vc) 1/	Ft./Sec.	6.2	11.0	4.2	8.7
Discharge Rate 1/	c.f.s.	300	3,360	280	816
Maximum W. S. Elevation 1/	Feet	1,516.1	1.280.0	1,260.3	1,252.3
Principal Spillway					
Capacity - Low Stage 2/	c.f.s.	16.7	46.2	23.2	63.6
Capacity - High Stage 2/	c.f.s.	41.8	115.5	58.0	159.0
Capacity Equivalents					
Sediment Volume					
Below Crest of Prin. Splwy.	Inches	0.39	0.48	0.65	0.57
Above Crest of Prin. Splwy.	Inches	0.32	0.37	0.50	0.46
Total	Inches	0.71	0.85	1.15	1.03
Detention Volume	Inches	3.46	4.55	3.77	3.77
Spillway Storage	Inches	3.89	5.05	4.58	2.18
Class of Structure	--	a	b	a	a

1/ Maximum during passage of hydrograph
2/ These are average capacities based on 0.8 times the peak capacity with the maximum head at the crest of the next stage
3/ Emergency spillway hydrograph is contained below crest of emergency spillway

May 1964

TABLE 3 - CONTINUED

ITEM	UNIT	STRUCTURE NUMBER 5	6	7
Drainage Area	Sq. Mi.	1.82	7.36	1.80
Storage Capacity				
Sediment	Ac. Ft.	107	240	70
Floodwater	Ac. Ft.	345	1,531	332
Total	Ac. Ft.	452	1,771	402
Between High and Low Stages	Ac. Ft.	209	985	197
Surface Area				
Sediment Pool	Acres	11	30	9
Floodwater Pool	Acres	50	190	46
Volume of Fill	Cu. Yds.	71,062	110,647	67,025
Elevation Top of Dam	Feet	1,294.8	1,308.8	1,337.6
Maximum Height of Dam	Feet	33.8	34.8	32.1
Emergency Spillway				
Crest Elevation	Feet	1,289.8	1,303.8	1,332.6
Bottom Width	Feet	40	40	40
Type	--	Rock	Veg.	Veg.
Percent Chance of Use	--	4	4	4
Average Curve No. - Cond. II	--	78	81	77
Emergency Spillway Hydrograph				
Time of Concentration	Hrs.	1.25	2.75	1.25
Storm Rainfall (6 hr.)	Inches	6.01	6.03	6.01
Storm Runoff	Inches	3.60	3.90	3.48
Velocity of Flow (Vc) 1/	Ft./Sec.	3/	3/	3/
Discharge Rate 1/	c.f.s.	3/	3/	3/
Maximum W. S. Elevation 1/	Feet	3/	3/	3/
Freeboard Hydrograph				
Storm Rainfall (6 hr.)	Inches	8.62	8.62	8.62
Storm Runoff	Inches	5.97	6.31	5.84
Velocity of Flow (Vc) 1/	Ft./Sec.	7.0	7.7	6.7
Discharge Rate 1/	c.f.s.	436	568	368
Maximum W. S. Elevation 1/	Feet	1,292.9	1,307.4	1,335.4
Principal Spillway				
Capacity - Low Stage 2/	c.f.s.	18.2	73.6	18.0
Capacity - High Stage 2/	c.f.s.	45.5	184.0	45.0
Capacity Equivalents				
Sediment Volume				
Below Crest of Prin. Splwy.	Inches	0.61	0.34	0.40
Above Crest of Prin. Splwy.	Inches	0.49	0.27	0.33
Total	Inches	1.10	0.61	0.73
Detention Volume	Inches	3.56	3.90	3.46
Spillway Storage	Inches	3.84	3.00	2.94
Class of Structure	--	a	a	a

1/ Maximum during passage of hydrograph
2/ These are average capacities based on 0.8 times the peak capacity with the maximum head at the crest of the next stage
3/ Emergency spillway hydrograph is contained below crest of emergency spillway

TABLE 3 - CONTINUED

STRUCTURE NUMBER						
8	9	10	11	12	13	14
2.05	1.60	1.24	1.04	1.30	1.25	1.37
53	84	54	52	42	59	58
378	295	229	198	247	237	261
431	379	283	250	289	296	319
230	175	136	119	149	143	157
7	10	8	6	10	9	11
47	41	35	30	38	34	42
60,840	57,684	58,319	53,567	44,153	47,850	61,034
1,338.5	1,349.1	1,374.2	1,368.0	1,425.0	1,398.6	1,380.1
33.0	36.3	32.2	29.0	30.0	33.1	29.0
1,333.5	1,344.1	1,369.2	1,363.0	1,420.0	1,393.6	1,375.1
40	40	40	40	40	40	40
Rock	Rock	Veg.	Veg.	Veg.	Rock	Rock
4	4	4	4	4	4	4
77	77	77	78	78	78	78
1.25	1.00	1.00	1.00	1.00	1.00	1.00
6.01	6.01	6.02	6.02	6.02	6.02	6.02
3.48	3.48	3.49	3.60	3.60	3.60	3.60
3/	3/	3/	3/	3/	3/	3/
3/	3/	3/	3/	3/	3/	3/
3/	3/	3/	3/	3/	3/	3/
8.62	8.63	8.62	8.63	8.63	8.62	8.63
5.84	5.85	5.84	5.98	5.98	5.97	5.98
6.9	7.0	6.2	5.9	6.0	6.4	6.4
412	424	300	256	272	320	320
1,336.5	1,347.2	1,371.7	1,365.3	1,422.4	1,396.2	1,377.7
20.5	16.0	12.4	10.4	13.0	12.5	13.7
51.3	40.0	31.0	26.0	32.5	31.3	34.3
0.27	0.55	0.45	0.53	0.45	0.50	0.45
0.21	0.43	0.36	0.41	0.15	0.38	0.35
0.48	0.98	0.81	0.94	0.60	0.88	0.80
3.46	3.46	3.46	3.56	3.56	3.56	3.56
2.94	3.04	3.14	3.34	3.77	3.04	3.44
a	a	a	a	a	a	a

TABLE 3 - CONTINUED

ITEM	UNIT	STRUCTURE NUMBER 15	16	17
Drainage Area	Sq. Mi.	1.46	6.30	5.26
Storage Capacity				
Sediment	Ac. Ft.	63	299	196
Floodwater	Ac. Ft.	277	1,529	999
Total	Ac. Ft.	340	1,828	1,195
Between High and Low Stages	Ac. Ft.	167	820	623
Surface Area				
Sediment Pool	Acres	10	44	26
Floodwater Pool	Acres	40	191	116
Volume of Fill	Cu. Yds.	49,773	129,761	278,605
Elevation Top of Dam	Feet	1,444.4	1,491.4	1,392.9
Maximum Height of Dam	Feet	28.4	32.0	39.0
Emergency Spillway				
Crest Elevation	Feet	1,439.4	1,484.9	1,387.9
Bottom Width	Feet	40	100	40
Type	--	Rock	Rock	Rock
Percent Chance of Use	--	4	2	4
Average Curve No. - Cond. II	--	78	80	78
Emergency Spillway Hydrograph				
Time of Concentration	Hrs.	1.00	2.50	2.25
Storm Rainfall (6 hr.)	Inches	6.05	8.63	6.05
Storm Runoff	Inches	3.63	6.21	3.63
Velocity of Flow (Vc) 1/	Ft./Sec.	3/	10.9	3/
Discharge Rate 1/	c.f.s.	3/	4,000	3/
Maximum W. S. Elevation 1/	Feet	3/	1,491.4	3/
Freeboard Hydrograph				
Storm Rainfall (6 hr.)	Inches	8.70	14.62	8.70
Storm Runoff	Inches	6.05	12.00	6.05
Velocity of Flow (Vc) 1/	Ft./Sec.	6.5	5.7	8.2
Discharge Rate 1/	c.f.s.	344	590	712
Maximum W. S. Elevation 1/	Feet	1,442.1	1,487.1	1,392.0
Principal Spillway				
Capacity - Low Stage 2/	c.f.s.	14.6	63.0	52.6
Capacity - High Stage 2/	c.f.s.	36.5	157.5	131.5
Capacity Equivalents				
Sediment Volume				
Below Crest of Prin. Splwy.	Inches	0.50	0.50	0.38
Above Crest of Prin. Splwy.	Inches	0.31	0.39	0.32
Total	Inches	0.81	0.89	0.70
Detention Volume	Inches	3.56	4.55	3.56
Spillway Storage	Inches	2.94	4.65	2.40
Class of Structure	--	a	b	a

1/ Maximum during passage of hydrograph
2/ These are average capacities based on 0.8 times the peak capacity with the maximum head at the crest of the next stage
3/ Emergency spillway hydrograph is contained below crest of emergency spillway

TABLE 3 - CONTINUED

STRUCTURE NUMBER						TOTAL
18	19	20	21	22	23	
4.25	1.48	1.49	1.04	10.36	1.15	68.59
163	64	56	45	337	45	2,851
807	281	283	239	2,376	212	14,231
970	345	339	284	2,713	257	17,082
503	170	171	119	1,221	126	8,340
20	11	8	8	44	8	372
95	47	48	31	278	37	1,861
191,356	77,963	69,463	62,804	227,270	53,469	2,310,432
1,405.2	1,458.2	1,498.4	1,489.3	1,508.4	1,508.5	xxxx
36.2	30.0	25.5	31.5	40.4	29.0	xxxx
1,400.2	1,453.2	1,493.4	1,484.3	1,500.7	1,503.5	xxxx
40	40	40	40	120	40	xxxx
Rock	Rock	Rock	Rock	Rock	Veg.	xxxx
4	4	4	2	2	4	xxxx
78	78	78	78	78	77	xxxx
2.00	1.00	1.00	1.00	3.50	1.00	xxxx
6.05	6.02	6.02	8.65	8.62	6.02	xxxx
3.63	3.61	3.61	6.00	5.97	3.49	xxxx
3/	3/	3/	5.2	6.2	3/	xxxx
3/	3/	3/	180	900	3/	xxxx
3/	3/	3/	1,486.2	1,503.2	3/	xxxx
8.70	8.63	8.64	14.65	14.66	8.68	xxxx
6.05	5.98	5.99	11.75	11.76	5.90	xxxx
8.1	6.4	6.3	9.2	11.8	6.2	xxxx
712	320	300	1,024	6,264	300	xxxx
1,404.3	1,455.8	1,495.9	1,489.3	1,508.4	1,506.0	xxxx
42.5	14.8	14.9	10.4	103.6	11.5	xxxx
106.3	37.0	37.3	26.0	259.0	28.8	xxxx
0.39	0.45	0.39	0.45	0.34	0.40	xxxx
0.33	0.36	0.32	0.36	0.27	0.33	xxxx
0.72	0.81	0.71	0.81	0.61	0.73	xxxx
3.56	3.56	3.56	4.30	4.30	3.46	xxxx
2.39	3.74	3.80	3.55	4.55	3.44	xxxx
a	a	a	b	b	a	xxxx

TABLE 4 - ANNUAL COSTS

Rock Creek Watershed, Kansas

(Dollars)

Evaluation Unit	Amortization of Installation Cost 1/	Operation and Maintenance Costs 2/	Total
Structural Measures	69,500	6,300	75,800

1/ 1963 prices amortized for 100 years at 3 percent interest

2/ Long term projected prices

May 1964

TABLE 5 - ESTIMATED AVERAGE ANNUAL DAMAGE REDUCTION BENEFITS

Rock Creek Watershed, Kansas

(Dollars)[1/]

Item	Estimated Average Annual Damage		Damage Reduction Benefits
	Without Project	With Project	
Floodwater			
Crop and Pasture	84,500	29,400	55,100
Other Agricultural	19,400	6,600	12,800
Road and Bridge	12,700	3,000	9,700
Railroad	600		600
Subtotal	117,200	39,000	78,200
Erosion			
Flood Plain Scour	19,100	9,600	9,500
Indirect	12,400	4,100	8,300
Total - On Project	148,700	52,700	96,000

1/ Price base - long term projected prices

May 1964

TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Rock Creek Watershed, Kansas

(Dollars)

Evaluation Unit	AVERAGE ANNUAL BENEFITS[1]						Average Annual Costs[2]	Benefit Cost Ratio
	Flood Prevention							
	Damage Reduction	More Intensive Land Use	Changed Land Use	Secondary	Benefits Outside Watershed	Total		
Structural Measures	92,700[3]	10,900	14,600	16,500	26,500	161,200	75,800	2.1:1

1/ Price base - long term projected prices

2/ Price base 1963

3/ In addition, it is estimated that land treatment measures will provide flood damage reduction benefits of $3,300 annually

May 1964

INVESTIGATION AND ANALYSIS

COOPERATION IN PLANNING

Engineering phases of watershed planning were accomplished with funds provided by the State of Kansas. These funds supplied the needed services through engineering contracts between the Soil Conservation Service and two Kansas engineering firms.

Services rendered under a contract with Servis, Van Doren, and Hazard, Engineers, Topeka, Kansas, were vertical control bench marks and hydraulic investigations.

A contract with Bucher and Willis, Engineers, Salina, Kansas, provided topographic maps of reservoirs, spillways and dam sites.

All other services were accomplished by the Soil Conservation Service Watershed Work Plan Staff and Work Unit Personnel.

PROJECT FORMULATION

The formulation of the structural system of this plan was accomplished jointly by the Soil Conservation Service and the Watershed District. The probable unit benefit per square mile for reservoirs in each subarea was developed and was graphically presented. These benefits were developed by evaluating a complete range of possible control by structures. All possible structures were located which were physically feasible and had a chance of economic justification. Costs were estimated for approximately 39 structures in this study. From this information 26 structures were selected for further study. Based on topographic and geologic surveys, three of these structures were eliminated due to economic and physical limitations. A system of 23 structures survived for the final plan.

ENGINEERING

Surveys

Vertical control lines were run throughout the watershed with permanent bench marks established within 1/2 mile of each structure site and each valley cross section. Eighty permanent bench marks were set in the watershed. All surveys were referenced to mean sea level.

Eighty-three valley cross sections were surveyed by kelsh plotter. Sufficient readings were made to define the topography along each section; to locate all crop boundaries and changes in roughness factor; to locate all roads, fences, and other objects along the sections; and to define the shape of the channel in detail.

Structure drainage areas were stereoscopically delineated on low level aerial photographs and measured with a planimeter.

Topographic maps of 26 structure sites were made by use of a kelsh plotter. The maps made by the kelsh plotter were developed from aerial photographs with a scale of 1 inch equals 800 feet. A maximum contour interval of 4 feet was used. Storage capacities were measured from the topography maps and stage-storage curves developed. Embankment quantities were calculated from centerline profiles which were surveyed on 26 sites by use of a kelsh plotter. The acceptable accuracy of the kelsh work was verified by checking approximately 12 percent of the centerline profiles by field surveying.

Structure Design and Cost Estimates

The 23 floodwater retarding structures are planned with two stage principal spillways. These provided an economical design for the design storm and kept the outflow at desirable levels. The crest of the first stage was planned at the elevation that provided the necessary sediment storage capacity in the reservoir. The second stage inlet was planned at the elevation that provided a 5-year detention storage. The crest of the emergency spillway was planned to provide a minimum 25-year detention storage above the principal spillway invert. The freeboard hydrograph was routed through all structures with the maximum elevation equal to or less than the elevation of the top to the dam. A minimum emergency spillway size of five feet deep by forty feet wide was used.

All structure drainage areas were stereoscopically delineated on aerial photographs. These were measured with a planimeter.

Structural data for each site is shown in table 3.

A cost estimate was calculated for each structure. Quantities of each item were based on surveyed data. Unit costs reflecting current bid prices for embankment, principal spillways, riprap, fencing, drain pipes, seeding, clearing, etc. were used to arrive at the total construction cost of each structure. Contingencies were calculated at 12 percent of the engineers estimate. Installation services costs were calculated as a percent of construction costs.

Easements and rights-of-way costs were calculated for each site using unit values for cropland and pastureland agreed on by the sponsors.

Individual structure costs data is tabulated in table 2 and the total cost of all proposed structures is shown in table 1.

HYDROLOGY AND HYDRAULICS

The watershed was divided into 18 subwatershed areas. Evaluation reaches were selected to coincide with the subwatershed area limits. For location see project map.

Hydrologic soil-cover complex numbers were developed for each subwatershed area for present and future watershed conditions. Future watershed conditions exist when the land treatment and cover measures outlined in this plan are in effect.

Rainfall frequency was obtained from United States Weather Bureau Technical Paper Number 40.

To obtain the relation of rainfall to runoff, the procedure as outlined in Chapter 3.10 National Engineering Handbook, Section 4, Hydrology, Supplement A, was followed. A factor of 4 was used for conversion of annual flood plotting positions to partial duration plotting positions. The frequency versus volume runoff relationship was developed for the needed range of hydrologic soil-cover complex numbers.

The relationship between discharge and inundation was based on 83 valley and channel cross sections. These cross sections were all related vertically to mean sea level datum. They were horizontally related by being located on aerial photographs. The width flooded at the cross section and the distance between cross sections determined area flooded.

The IBM 650 electronic computer was used to make calculations for the hydraulics of the flood plain. A range of discharges was considered from below non-damage flow to above the 100-year frequency. The output from the computer gave elevation and area of inundation by depth increments for every discharge computed at each cross section.

Plan-profile sheets were prepared for the entire flood plain. Profiles were plotted showing the channel bottom, flow line, bank line, and at least four discharges. The plan map is a half-tone aerial photo of the flood plain projected onto the plan-profile sheets.

The relationship of discharge to area of inundation by depth increments was developed for each reach by combining data for all cross sections within each reach.

The relation of unit volume runoff to discharge was developed by floodrouting using Wilson's method. Triangular hydrographs, representing the unit volume of runoff from each subwatershed, were used. Floodrouting determined the discharge for a unit volume of runoff for each evaluation reach. This determination was made for present conditions, future land treatment conditions, future land treatment conditions with various percentages of each subwatershed controlled by floodwater retarding structures, and future land treatment conditions with the formulated structural system. This gave the discharge-volume runoff relations for each evaluation reach considering a 0 to maximum percent range of area controlled by reservoirs and with the structural system presented in this plan.

Frequency discharge and frequency area flooded relationships were tabulated for each of the above conditions.

A determination was made of the frequency of two historical storms which occurred in the watershed in 1958 and 1961. This was accomplished by securing high water marks for these storms and plotting them on the water surface profiles. This made it possible to determine the discharge of the actual storm at each reach. The discharge-frequency curve and the above discharges determined the frequency of the two storms at each reach.

Floodwater retarding structure release rates were established considering downstream channel capacities. Two stage release rates are planned in all structures. Combined maximum release rates will not exceed channel capacity. Individual structure release rates are shown in table 3.

The floodwater detention storage volume was determined by procedures in SCS Technical Release Number 10, modified to include effect of a saturated soil condition on incremental rainfall after the first day's precipitation. Storms used in connection with this procedure were taken from Weather Bureau Technical Paper No. 40. The volume for flood storage up to the second stage was computed using 5-year frequency storms. The total volume for floodwater storage in all structures was computed using 25-year frequency storms.

Dimensions of the emergency spillways were determined by floodrouting the storms indicated in SCS Engineering Memorandum No. 27 by the method outlined in Lincoln E&WPU Memorandum No. 2. Emergency spillways will exceed minimum criteria as established by the State of Kansas.

GEOLOGIC INVESTIGATIONS

Sedimentation in Reservoirs

Sediment rates and volumes were determined from sedimentation surveys made on existing reservoirs in the area. The range survey method was used to determine the sediment volume accumulated in each reservoir. Equipment used included survey instruments, boat, cable and meter, spud bar, and sounding bell.

Delta deposits were measured at from five to ten percent of the total sediment volume.

The significant sediment production factors of soil type, slope of the land, land use, and type of erosion were mapped on the drainage area above each surveyed reservoir. Sediment rates were computed for each reservoir. Variations in the sediment rates were equated to the difference in the sediment producing factors of the drainage area.

Sediment rating curves were developed from the above computations. These curves show sediment yield in acre feet per square mile per year

versus drainage area size. The curves were plotted for a range of sediment producing factors.

Sediment producing factors of the drainage areas above floodwater retarding structures were mapped and compiled. Sediment yield to each reservoir was read from the sediment rating curves. An additional 10 percent was added above the sediment pool for delta deposition on reservoirs having a drainage area in excess of two square miles.

Flood Plain Scour

The extent and severity of sheet scour and channel scour resulting from floods on the flood plain were determined from field surveys. The scour areas were mapped on aerial photographs. The degree of damage was based on the loss of productivity as compared with the unaffected parts of the field. Information derived from interviews with work unit personnel, soil scientists, and farmers aided in assembling land damage information.

Sheet and channel erosion was tabulated in acres with the percent of damage in each of the evaluation reaches. Only eroded areas affected by upstream runoff were considered.

Future scour erosion in the next 50 years was estimated without the program for each reach. Future damage was based on soil type, present soil depth on the eroded areas, and the annual rate of erosion. The future damages were computed by:

> Present percent of damage divided by years of accelerated erosion times 50 years plus present percent of erosion is equal to percent of damage in 50 years (not to exceed 100 percent).

The recovery period for each reach in years was established from the amount of damage, the soil type, and the length and number of crop rotations required for potential recovery.

The potential recovery of soil productivity without floods depends primarily on the capability class of the soil and the present soil depth. Affected areas having soil with 60 inches or more in depth and in Class I and II are considered capable of full recovery. Other classes of land with less depth of soil were considered to recover partially as compared to original productiveness.

The percent of recovery for each evaluation reach at the end of the recovery period was determined by:

> Present damage times percent of potential recovery times percent of area control is equal to percent of recovery.

Dam Sites

A geologic investigation was conducted at each proposed dam site. The work was accomplished by field observation, use of existing geologic maps, surveying instruments and hand and power augers. The report on each dam site includes a centerline profile showing geologic conditions. The borrow area is shown on the topographic map and a summary sheet attached.

Significant geologic features that might influence the design or construction of a structure were investigated. A limited number of test holes on the centerline determined the stability of the foundation. The amount of stripping and the depth of core trench were noted from the logs of the test holes.

The recommended location of the principal spillway was determined from the stability of the foundation, amount of excavation, length of conduit and the alignment of the pipe outlet to the stream channel. Quantities of materials to be excavated from the emergency spillway were estimated and their potential uses during construction were determined.

All soils investigated were classified by the Unified Soil Classification.

ECONOMIC INVESTIGATIONS

The Frequency Method as described in Chapter 3 of the Economics Guide was followed in determining the average annual floodwater damages.

The watershed was divided into eighteen subwatersheds with evaluation reaches set to coincide with the subwatersheds.

Basic data necessary for the determination of damages were collected by personal contacts with farm operators, township and county officials, and with local agricultural technicians. Damage schedules were obtained from 40 to 80 percent of the landowners and operators of the flood plain area in each evaluation reach and the values expanded to 100 percent. The specific storms covered were September 10, 1961, and a minor storm in July, 1958. From rainfall records and high water marks, the frequency of these storms were determined for each evaluation reach. The damage schedules covered other agricultural damages such as losses of livestock, machinery, and stored grains; removal of debris; and damage to private roads, channel crossings, and fences.

Damages were computed by types in each of the evaluation reaches over the evaluation period for present land treatment conditions, future land treatment conditions, for a range of structure control up to a maximum, and with the formulated works of improvement in place. Benefits were computed for more intensive use and changed land use under these same conditions.

Floodwater damage to crops reflects the net loss in income for the 100-year storm series. It was computed by the determination of acres of cropland flooded and their depths of inundation. A composite acre of flood plain use was determined by interviews with farm operators and checked by field reconnaissance.

Average crop yields for the area, adjusted to flood-free conditions by judgment of farm operators and agricultural technicians familiar with the area, were used in the evaluation. A different composite acre and average yields were developed in a similar manner for use in determining the benefits attributable to more intensive use and changed land use. The composite acre of crops on the flood plain and their flood-free yields are as follows:

Crops	Present Use Percent Use	Flood-free Yield
Alfalfa	20	4 Ton
Corn	5	70 Bu.
Milo	17	80 Bu.
Wheat	28	40 Bu.
Timber	10	--
Forage Sorghums	3	21.5 Ton
Soybeans	2	30 Bu.
Tame Grasses	10	15 A.U.M.
Oats	2	60 Bu.
Barley	3	50 Bu.

Crops	More Intensive Use Percent Use	Flood-free Yield
Alfalfa	20	4.5 Ton
Corn	5	73 Bu.
Milo	17	83 Bu.
Wheat	28	45 Bu.
Timber	10	--
Forage Sorghums	3	25 Ton
Soybeans	2	35 Bu.
Tame Grasses	10	15 A.U.M.
Oats	2	60 Bu.
Barley	3	55 Bu.

The net value of the composite acre was weighted using lower values in the scoured areas. The damageable values by depth increments were adjusted to reflect the weighted values.

A percent loss from each crop was developed considering depth of inundation and month of flooding. The percent damage was used to determine damage for the composite acre. The rates of damage thus developed were weighted by the percent of the year's excessive storms that occur

in each month and the weighted rate multipled by acreages inundated by selected discharges. A dollar damage versus discharge curve was developed to provide a monetary value for each storm discharge in the 100-year storm series.

Road and bridge damages were based on information obtained from the county engineers office as to their repair or replacement costs. Road damages were computed as the dollar damage per foot by depth increments of inundation for the various types of road surfaces within the watershed. Bridge damages were estimated on individual bridges by various discharges. Road and bridge damages were then combined in each evaluation reach and dollar damage versus discharge curves were plotted. These curves were then applied to the 100-year storm series.

Indirect damages such as depreciation of property in the flooded areas, loss of time and additional expenses of operators used in repair and clean-up which would normally be used in a productive operation, and additional distances driven by rural mail carriers, school busses, and farmers because of flooded roads, were considered. The indirect damages were computed as 10 percent of the crop and other agricultural damages and 15 percent of road, bridge, and railroad damage.

The estimate of damages to land through flood plain scour was derived from data gathered in the field by the geologist regarding acres damaged, severity of damage, and period and degree of recovery due to the installed program. The economic evaluation was based on the net value of the composite acre. The changes in net income due to scour damage were discounted at a 6 percent interest rate.

The off-project benefits assigned to the Rock Creek project are its fair share of the benefits accruing to the Soil Conservation Service watershed projects from the 19,800 acres of affected Walnut River flood plain. These benefits were jointly evaluated by the Kansas Board of Water Resources; Corps of Engineers, Tulsa District; and the Soil Conservation Service and are presented in the Survey Report on Walnut River, Kansas, 1963.

It was estimated that 551 acres of pasture land interspersed with brush and trees in localized areas adjacent to the streambanks will be cleared and used for crop production. This determination was supported by interviews with farmers, measurements of aerial photos, and from past experiences within the pilot watersheds. The farm owners and operators reported that where the topography allows, and where the expected frequency of damaging floods can be substantially reduced, that this change of land use will occur.

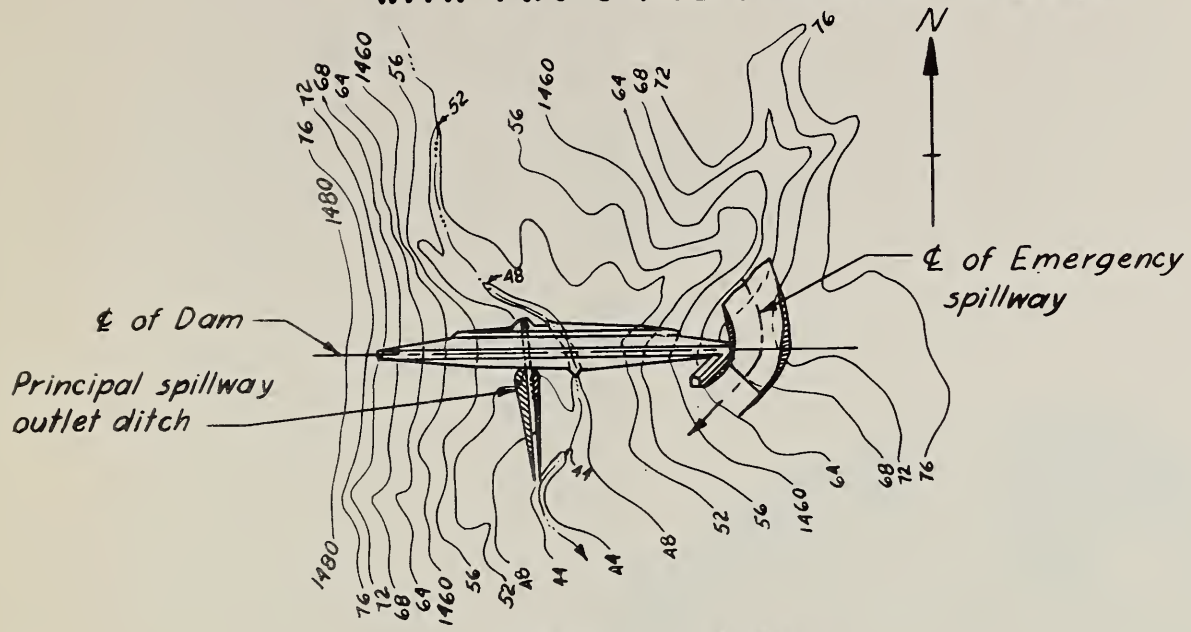
Secondary benefits were computed on two conditions using procedures outlined in Watersheds Memorandum SCS-57. One condition was the value of local secondary benefits stemming from the project. These values were determined as 10 percent of the direct primary project benefits. Indirect

benefits were excluded from consideration in computing secondary benefits. The second condition was the value of local secondary benefits induced by the project. These values were determined as 10 percent of the increased costs that primary producers will incur in connection with increased production. These benefits were used in project justification and are included in the over-all B:C ratio of the program.

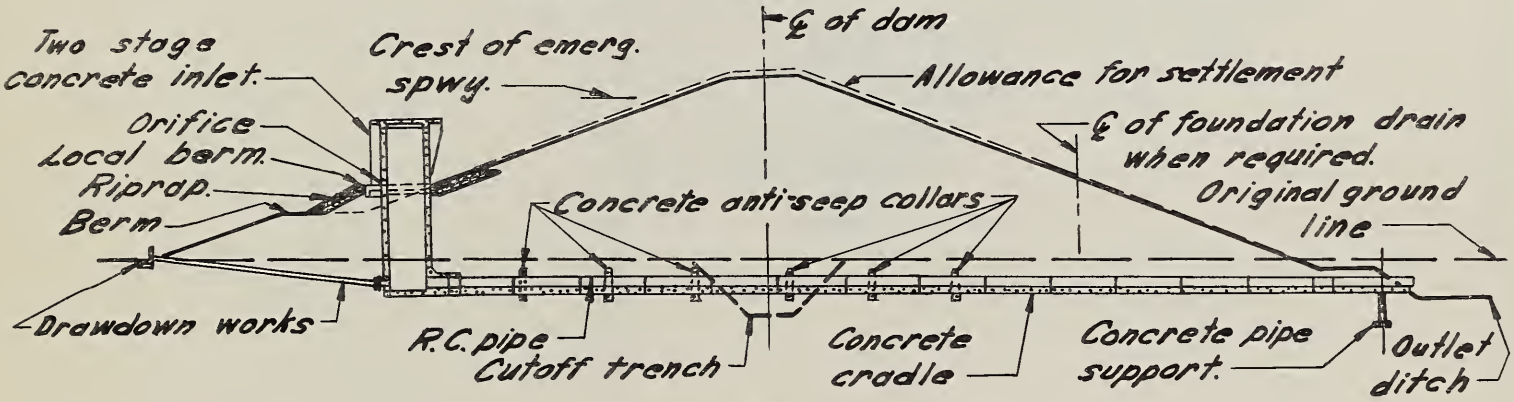
The cost of easements and rights-of-way were based on the value of cropland and pasture as determined by the Rock Creek Watershed Directors. These values, slightly higher than the capitalized value of net production, were used for project evaluation. The values agreed on were $100 per acre for upland and second bottom cropland, $200 for first bottom cropland and $80 per acre for pasture for the floodwater detention sites. Land costs of the sediment pool areas were based on 100 percent of its value, the structure and spillway areas on 75 percent, and the detention areas on 50 percent. The productive capacity retained under future conditions was thereby considered.

All monetary evaluations for benefits were based on long-term projected prices using "Agricultural Price and Cost Projections," Agricultural Research Service, dated September, 1957. Nineteen-sixty two construction costs as experienced in Kansas P.L. 566 projects under construction were used to estimate the construction costs of structural measures. Operation and maintenance costs were computed at 0.4 percent of construction cost for floodwater retarding structures. This factor also reflects long term projected price levels. This method of computing O and M costs (outlined by the Lincoln, Nebraska, Engineering and Watershed Planning Unit) is based on the principle that the relative probability of need for major type repairs decreases as the number of structures increases. Federal and local costs were amortized at 3 percent interest rate for a period of 100 years.

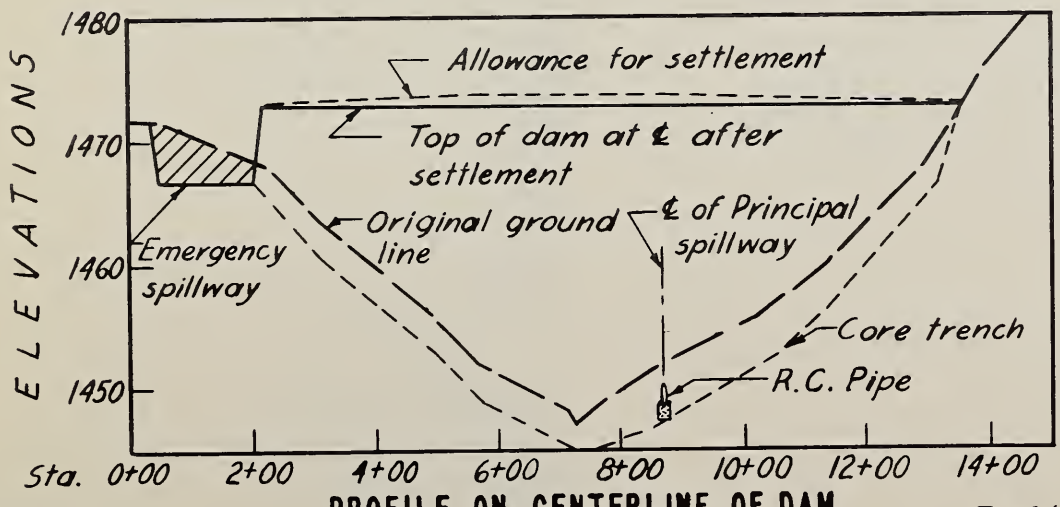
TYPICAL FLOODWATER RETARDING STRUCTURE WITH TWO STAGE PRINCIPAL SPILLWAY



GENERAL PLAN



CROSS SECTION OF DAM ON CENTERLINE OF TWO STAGE PRINCIPAL SPILLWAY



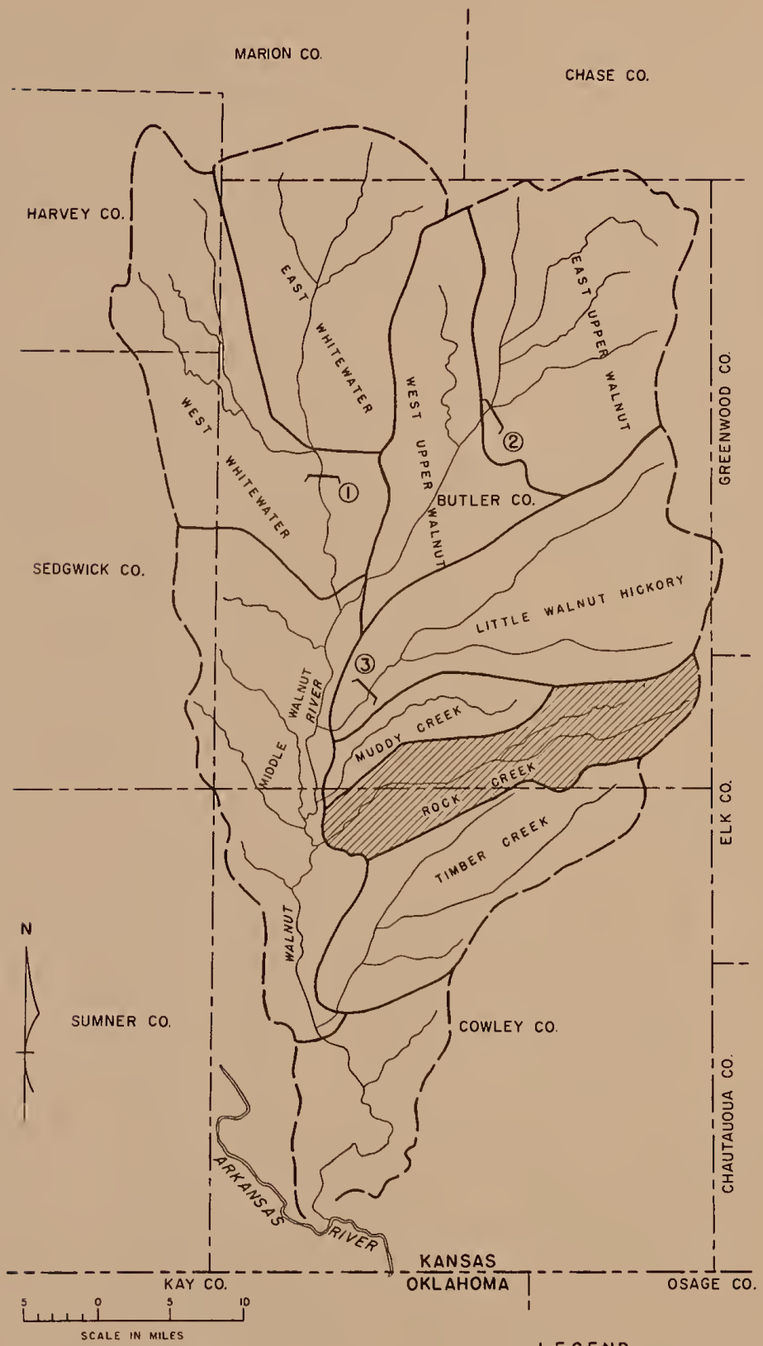
PROFILE ON CENTERLINE OF DAM

USDA-SCS

USDA SCS-LINCOLN, NEBR. 1961

7-61 5,L-17,778

WATERSHED PROJECTS LOCATION
WALNUT RIVER BASIN



KEY

DAM SITES PROPOSED BY CORPS OF ENGINEERS

① TOWANDA RESERVOIR
② EL DORADO RESERVOIR
③ DOUGLASS RESERVOIR

LEGEND

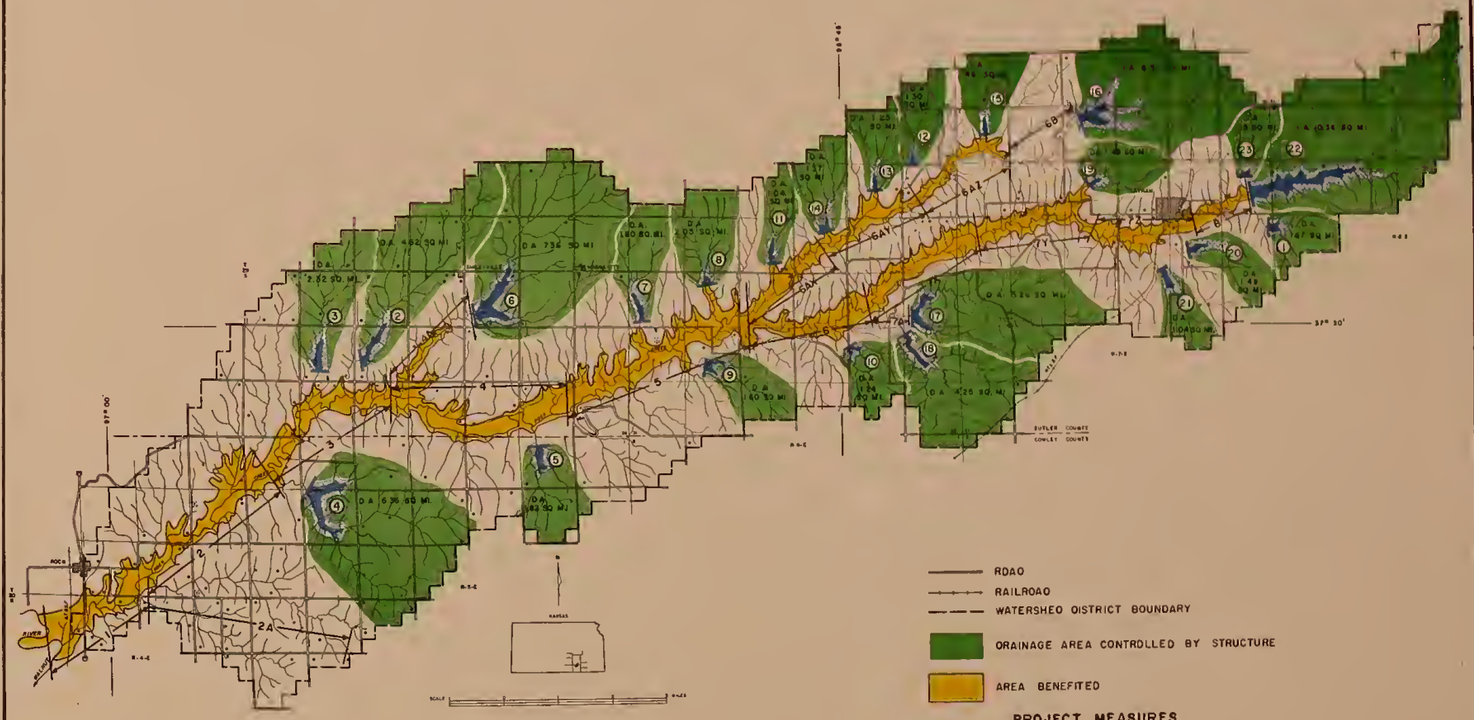
WALNUT RIVER WATERSHED BOUNDARY

PROJECT WATERSHED BOUNDARY

5,P-19,705

U. S. DEPARTMENT OF AGRICULTURE — SOIL CONSERVATION SERVICE

PROJECT MAP
ROCK CREEK WATERSHED
BUTLER AND COWLEY COUNTIES
KANSAS



5,S-20,069